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A REVISION OF SOME ARIZONA CACTACEAE

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THE CACTACEAE, like other succulent groups, are frequently neglected because of the common impression that specimens are impossible to prepare or are not worth much after they are made. It is hoped that recently published articles at least have helped to dispel this notion (Benson, 1939; Peebles, 1942). Mr. Peebles has given a particularly thorough account of preparation of cactus specimens, and it is illustrated with excellent photographs. Lack of adequate series of herbarium specimens tends to place the burden of study of the Cactaceae upon examination of living individuals in the field. Despite the many advantages of this procedure and its absolute necessity, it is impossible to make adequate comparisons from individual to individual without intervening lapse of time, and it is difficult for one person to visit all of the localities in which a particular species is to be found.

When "The Cacti of Arizona" was published (Benson *et al*, 1940), the writer was impressed by the close relationship of a number of described species, but evidence of intergradation was not available in the plants examined in the field or in the inadequate herbarium material. Continued study in the field and preparation and acquisition of additional herbarium specimens have resulted in the following rearrangement of species, particularly in the genus *Echinocereus*.

Symbols for herbaria in which specimens are deposited are as follows: *Sac*, U. S. Field Station, Sacaton, Arizona; *UA*, University of Arizona, Tucson; *B*, Herbarium of Lyman Benson, Pomona College, Claremont, California; *Mo*, Missouri Botanical Garden, St. Louis, Missouri; *US*, United States Na-

tional Herbarium, Smithsonian Institution, Washington, D. C.; *NY*, New York Botanical Garden, New York City; *S*, Dudley Herbarium, Stanford University, California; *Mich*, University of Michigan, Ann Arbor. A few of these specimens have been examined only in figures or photographs. The herbarium of the writer is now a part of the Pomona College Herbarium.

The vegetation types referred to are as follows (cf. Benson, 1942; Shreve, 1936, 1942; Shantz and Zon, 1924) :

Circumboreal Flora

Rocky Mountain Forests (spruce-fir and yellow pine)

Eastern Forest Flora

Sierra Madrean Flora

Southwestern Oak Woodland and Chaparral

Southwestern Coniferous Woodland (juniper-pinyon)

Northern Desert (sagebrush)

Central Prairie Flora

Short Grass Prairie (Great Plains grassland)

Desert Grassland

Mexican Desert Flora (creosote bush)

Mojavean Desert

Sonoran Desert

Chihuahuan Desert

OPUNTIA

Opuntia acanthocarpa Engelm. and Bigel.

Opuntia acanthocarpa ENGELM. and BIGEL., 1856, Pae. R. R. Rept., 4: 51, pl. 18, f. 1-3.

Typically an erect, arborescent shrub 1-2 m. high but sometimes lower or even sprawling; main trunk very short, usually less than one-fifth the height of the plant, the crown of long branches not dense; branches cylindrical, the joints 1.5-3 dm. long or longer, mostly about 2-3 cm. in diameter, the surface bearing areoles about 18-30 mm. long and about 6 mm. broad, laterally compressed; spines about 10-12 at an areole, the larger ones 2.5-3.7 cm. long, rather dense on the branches and more or less obscuring the surface of the stem, straw-colored, the sheaths conspicuous and persistent; glochids minute; petals remarkably variable in color, most frequently red or yellow, the flower 2.5-3.7 cm. in diameter; fruit dry and more or less shrivelled at maturity, spiny, not giving rise to flowers at the areoles (not proliferous) and not persistent.

Abundant on sandy flats and in washes in the Mojavean and Sonoran Deserts at 2,000 to 4,000 feet elevation. California in the southern and eastern parts of the Mojave Desert and in the western part of the Colorado Desert; southern Nevada; southwestern Utah; Arizona from western Mohave County and northern Yuma County to the Verde River and the Tucson Mountains and southward to Sonora.

Type collection: "On the mountains of Cactus Pass, about 500 miles west of Santa Fé." *Bigelow, Mo.*

Opuntia acanthocarpa var. **Thornberi** (Thornber and Bonker) L. Benson,
comb. nov.

Opuntia Thornberi THORNBER and BONKER, 1932, Fantastic Clan, 133, 148, pl. opposite 134,
upper fig.

Bushy cholla occurring in patches 1 m. or more in diameter; joints of the main stem 4 dm. or more in length; tubercles 3-5 cm. long, about 6 mm. broad and 6 mm. high; spines 7-10, not forming a dense mass on the stem, much less conspicuous than the surface of the stem, 1.5-2.2 cm. long.

Gravelly soil of washes, flats, and alluvial fans in the Mojavean and Sonoran deserts at 1,500 to 3,500 feet elevation. Peach Springs, Mohave County, and southeastward along the edge of the desert below the Mogollon Rim to northwestern Graham County and northeastern Pima County. Many of the plants occurring within a 10 mile radius of Hillside, Yavapai County, are intermediate between this and the typical variety.

Type collection: "*Opuntia Thornberi* has been described only very recently. . . ." There is no evidence of description elsewhere. No type is given, but fortunately the line drawing is excellent.

Opuntia Stanlyi Engelm.

Opuntia Stanlyi Engelm. in EMORY, 1848, Notes Mil. Recon. p. 157.

Corynopuntia Stanlyi F. M. Knuth in BACKER and KNUTH, 1935, Kaktus ABC, p. 114.

Low-growing cholla consisting of a clump of short, erect or ascending branches 1-3 dm. high, the clumps often 3-7 m. in diameter; joints narrowed below, 1-2 dm. long, usually 3-5 cm. in diameter, the surface bearing conspicuous, mammillate tubercles about 2.5-4 cm. long, 6-12 mm. broad, and about 6-8 mm. high or in an extreme form 12-18 mm. high, not tending to join one another or to form ridges along the joint; spines 10-18, those of a single areole 1.3-5 cm. long, the larger ones commonly 1-1.5 mm. broad, but sometimes 2-3 mm. broad, tan or brownish or sometimes red, strongly flattened, sheaths wanting or rudimentary and adherent to the tip of the spine, papillate-roughened; glochids large; petals yellow, the flower about 2.5-3 cm. in diameter; fruit markedly spiny, yellow.

Rocky or sandy mesas or arroyo banks in the Sonoran Desert at 2,500 to 5,000 feet elevation. Arizona on the San Pedro River above Winkleman and from the eastern edge of Aravaipa Valley to the upper Gila River Valley and Clifton, Duncan, and the San Simon Valley (Graham, Greenlee, and Cochise counties); New Mexico on the Gila River.

Type collection: "October 22d, 1846. Abundant on the Del Norte and Gila." Type not preserved. On page 63, the location of the camp of Oct. 22, 1846, is given as Lat. 32° 38' 13"; Long. 109° 07' 30". This is just south of the Gila River on the boundary between the present states of Arizona and New Mexico.

Opuntia Stanlyi var. **Kunzei** (Rose) L. Benson, comb. nov.

Opuntia Kunzei ROSE, 1908, *Smiths. Misc. Coll.*, 50: 505.

Joints narrowed below, 7.5–15 cm. long, 2.5–3.5 cm. in diameter; tubercles distinct, about 1.5–2.5 cm. long, narrower and lower than in the typical variety; fruit (as far as known to the writer) 3.3–5 cm. long, 12–14 mm. in diameter.

Plains at 1,000 to 2,000 feet elevation. Maricopa Mountains to Casa Grande and southwestward to the Gunsight Mountains and southward to Baboquivari Valley. Perhaps occurring in Sonora.

Type collection: Pima County, Arizona, *Dr. R. E. Kunze*.

Opuntia Stanlyi var. **Wrightiana** (Baxter) L. Benson, comb. nov.

Grusonia Wrightiana BAXTER, 1935, *Calif. Cactus*, p. 58.

Opuntia Wrightiana PEEBLES, 1937, *Desert Plant Life*, 9: 43.

Joints nearly cylindrical, 1–1.5 or 2 dm. long, 2.5–3.5 or 4 cm. in diameter; tubercles tending to be confluent into ribs on the stem, 12–18 mm. long, 3–4 mm. broad, 3–5 mm. high; fruit 3.3–5 cm. long, about 12–14 mm. in diameter.

Sand and clay soils of valley floors in the Sonoran Desert at 300 to 1,500 feet elevation; restricted to regions of 1–5 inches of annual rainfall. Southeastern edge of California; Arizona from Detrital Valley, Mohave County, to Yuma County and the western edge of Pima County; southward as far as St. George's Bay, Sonora.

Type collection: "Type Specimen: Three joints, one with fruit, collected by Allan B. Clayton, April 15, 1934, and deposited in the Dudley Herbarium of Stanford University. Type Locality: Petrified forest near the Colorado River, four miles west of the Quartzite-Yuma road, 33 miles north of Yuma, Arizona."

Opuntia erinacea Engelm. and Bigel.

Opuntia erinacea ENGELM. and BIGEL., 1856, *Pac. R. R. Rept.*, 4: 47, pl. 13. f. 8–11.

Low-growing prickly pear forming clumps 0.3–1 m. in diameter, commonly 1–1.5 dm. high, the stems usually 2–4 jointed; joints ovate to elliptic-oblong or oblong, flat, 5–15 or 20 cm. long, 5–7.5 cm. broad, glabrous; areoles usually about 8–10 mm. apart, all spine-bearing; spines 4–7 or 9, the longer ones about 5 cm. long, more or less stiff, somewhat flattened, elliptic in cross section, white or pale gray; glochids 1.5–3 mm. long; petals yellow, white, deep pink, or red, the flower about 5–6 cm. in diameter; fruit dry at maturity, more or less cylindrical, about 3 cm. long, 12–14 mm. in diameter, spiny.

Alluvial areas in the Mojavean Desert at 1,500 to 3,000 feet elevation. California in the southeastern Mojave Desert; southern Nevada; southwestern Utah; northwestern Arizona in Mohave County; Havasupai Canyon, Coconino County; near Carrizo, Apache County.

Type collection: "West of the great Colorado near the Mojave Creek." *Bigelow* in 1853–4, *Mo.*

Opuntia erinacea var. **ursina** (Weber) Parish.

Opuntia ursina Weber in Boiss., 1898, Dict. Hort., 2: 896.

Opuntia erinacea var. *ursina* Parish in JEPSON, 1936, Fl. Calif., 2: 542.

Similar to the typical variety; joints obovate to oblong, 1–2 cm. long, 6–7.5 cm. broad; areoles all spine-bearing; spines usually 6–14, the longer ones remarkably flexible and thread-like, white or pale gray, not deflexed.

Rocky mountain slopes in the Mojavean Desert at 2,000 to 3,000 feet elevation. California in the southeastern part of the Mojave Desert; Arizona at scattered stations in Mohave County.

Type collection: Ord Mountains, southern Mojave Desert in San Bernardino County, California.

Opuntia erinacea var. **hystricina** (Engelm. and Bigel.) L. Benson
comb. nov.

Opuntia hystricina ENGELM. and BIGEL., 1856, Pac. R. R. Rept., 4: 44, pl. 15. f. 5–6.

Joints obovate, 5–10 or 15 cm. long, 3.7–7.5 or 9 cm. broad, areoles all or all but the lowest spine-bearing; spines 4 or usually 5–8, the longest ones 4.5–7.5 or 10 cm. long, tending to be rigid, deflexed; petals red or yellow.

Plains and mountains in the Southwestern Coniferous Woodland, the Short Grass Prairie, and the Rocky Mountain Forests at 4,500 to 7,000 feet elevation. Northern Arizona from Coconino County to Apache County; northern New Mexico. Flowering in June.

Type collection: "... Abundant from the Rio Grande westward to the San Francisco mountains, . . . The specimens before us were obtained at the Colorado Chiquito and on the San Francisco Mountains." *Bigelow* in 1853–4, *Mo.*

Opuntia erinacea var. **rhodantha** (K. Schum.) L. Benson, comb. nov.

Opuntia rhodantha K. SCHUM., 1897, La Semaine Hort.; ——— 1898 Gesamtb. Kakteen. 735.

Joints obovate, 5–10 cm. long, 3.7–7.5 cm. broad, more or less lead-colored (in the other varieties green); usually only the distal areoles of each joint spine-bearing, those on at least the lower half of the joint usually spineless; spines 1–6 or 8, the longer ones 2.5–3.7 cm. long, tending to be rigid, deflexed; flowers usually red but sometimes yellow (*e.g.* McGee Creek, Mono County, California, *L. Benson 11212, UA, B.*).

Flats and rocky hills in the Southwestern Coniferous Woodland, the Northern Desert, and the Rocky Mountain Forests at 5,000 to 8,000 feet elevation. California along the east side of the Sierra Nevada in southern Mono County and Inyo County (Big Trees Camp, Lake Sabrina Road above Bishop, *L. Benson 6009, B*) and eastward to western Nebraska; Arizona from Mt. Dellenbaugh, Mohave County, to Prescott, the Mogollon Rim, the northern end of the White Mountains and northeastward.

Type collection: "Colorado, bei 200—2300 m Höhe: PURPUS; blühte bei SPATH im Juni . . ."

***Opuntia compressa* (Salisb.) Macbr.**

Plate 25, fig. A, 3

Cactus Opuntia L. 1753, Sp. Pl., p. 468.*Cactus compressus* SALISB., 1796, Prodr., p. 348.*Opuntia compressa* MACBR., 1922, Contr. Gray Herb., (65) : 41.*Opuntia vulgaris* of authors, not of MILL., 1768.

Low, prostrate or nearly prostrate prickly pear; roots fibrous; joints light green, broadly obovate to nearly circular, 4–11 cm. long, 4–9 cm. broad; leaves 4–5 mm. long, more or less appressed; spines none or solitary in the distal areoles; petals pale yellow, the flower about 5 cm. in diameter, "with about 8 petals"; fruit 2–3 cm. long.

Dry gravelly or sandy soil in the Eastern Forest Flora at low elevations. Southern New England and southward along the Atlantic coastal plain to South Carolina. This species is represented westward by varieties, and the Arizona plants of both fibrous-rooted and tuberous-rooted types tentatively are referred to them.

***Opuntia compressa* (Salisb.) Macbr. var. *microsperma* (Engelm.)**

L. Benson, comb. nov.

Cactus humifusus RAF., 1820, Ann. Nat., p. 15.*Opuntia humifusa* RAF., 1830, Med. Fl. U. S., 2 : 247.*Opuntia mesacantha* RAF., 1830, Bull. Bot. Seringe, p. 216.*Opuntia cacspitosa* RAF., 1830, *loc. cit.**Opuntia Rafinesquii* ENGELM., 1856, Pac. R. R. Rept., 4 : 41, pl. 11. f. 1–3.*Opuntia Rafinesquii* var. *microsperma* ENGELM., 1856, *loc. cit.**Opuntia cymochila* ENGELM. and BIGEL., 1856, Pac. R. R. Rept., 4 : 43, pl. 12. f. 1–3.*Opuntia stenochila* ENGELM. and BIGEL., 1856, *loc. cit.*, p. 44, f. 4–6.*Opuntia mesacantha* var. *microsperma* COULT., 1896, Contr. U. S. Nat. Herb., 3 : 429.*Opuntia mesacantha* var. *cymochila* COULT., 1896, *loc. cit.*, p. 430.*Opuntia mesacantha* var. *stenochila* COULT., 1896, *loc. cit.*, p. 430.

Roots fibrous; joints dark green, averaging a little larger than in the typical variety, 7–12 cm. long, 5–10 cm. broad; leaves "6–8" mm. long, not appressed; spines mostly 1–3, one much larger than the other (accessory) ones; petals "10–12"; fruit 3–4 cm. long. (*Fig. A 3.*)

According to Peebles, *apud* Kearney and Peebles, U. S. Dept. Agric. Misc. Publ., (423) : 611, 1942, this plant, designated as *O. Rafinesquii*, occurs in northern Arizona from "Apache County to northern Mohave County, not common, 5,000 to 7,000 feet . . ." The writer has seen no Arizona specimens. This wide-ranging middle western variety of the eastern *Opuntia compressa* is exceedingly variable. It includes a host of minor forms variously considered as species and varieties, and some may be worthy of segregation as varieties.

Type collections: (1.) *C. humifusus*, "From New York to Kentucky and Missouri." (2.) *O. mesacantha*, Kentucky to Louisiana. (3.) *O. cacspitosa*, Kentucky and Tennessee. (4.) *O. Rafinesquii*, *nom. nov.* for the first three described species, and antedated by all of them. No type designated and only the general range given. (5.) Var. *microsperma*. No type designated and the range not distinguished from the broad range of the typical

variety (of *O. Rafinesquii*) in the Mississippi Valley. (6) *O. cymochila*, called a subspecies, but the name published as a binomial, "On the Camanche plains east of Llaño Estacado, near the 100th degree of longitude; and from there to Tueumcari, 80 miles east of the Pecos" in New Mexico. *Bigelow* in 1853-4, *Mo.* (7.) *E. stenochila*, called a subspecies but published as a binomial, "At the Canyon of the Zuñi," *Bigelow* in 1853-4, *Mo.*

***Opuntia compressa* var. *macrorhiza* (Engelm.) L. Benson, comb. nov.**

Plate 25, figs. A, 1, 2

Opuntia macrorhiza ENGELM., 1850, Bost. Jour. Nat. Hist., 6: 206.

Opuntia fusiformis ENGELM. and BIGEL., 1856, Pac. R. R. Rept., 4: 43.

Opuntia mesacantha Raf. var. *macrorhiza* COULT., 1896, Contr. U. S. Nat. Herb., 3: 430.

Opuntia plumbea ROSE, Smiths. Misc. Coll., 1908, 50: 524.

Opuntia delicata ROSE, 1911, Contr. U. S. Nat. Herb., 13: 310.

Opuntia Loomisii PEEBLES, 1938, Cact. and Succ. Jour., 9: 109.

Similar to var. *microsperma*; roots tuberous even in young plants; spines commonly 2 or more per areole.

Plains and hills in the Desert Grassland, the Southwestern Coniferous Woodland, the Southwestern Oak Woodland, and the Rocky Mountain Forests at 4,500 to 6,000 feet elevation and (eastward) in the Short Grass Prairie and in the Eastern Forest Flora. Arizona from Mohave County to Apache County, eastern Pima County, and Santa Cruz County; eastward to Missouri and Texas. The Arizona form is variable. Usually it is longer-spined and often the joints are larger. Some forms approach the fibrous-rooted species, *Opuntia phacacantha*.

Type collections: (1.) *O. macrorhiza*, "Naked, sterile, rocky places on the Upper Guadalupe." Texas, *Lindheimer*, *Mo.* (2.) *O. fusiformis*, called a subspecies, but published as a binomial, "Cross-timbers longitude 97°-99°..." *Bigelow* in 1853-4, *Mo.* (3.) *O. plumbea*, San Carlos Indian Reservation, Arizona, Coville in 1894, *US*. This form is apparently identical with that on the Great Plains. A specimen (Pearce, Cochise County, *Nichol* in 1940 [pl. 25 fig. A, 1]) is growing in the Pomona College botany greenhouse. (4.) *O. delicata*, "Type U. S. National Herbarium no. 454622, collected by J. N. Rose at Calabasa, April 30, 1908 (no. 11951)." Arizona. (5.) *O. Loomisii*, "Type, *H. F. Loomis* No. SF. 298, Prescott, Arizona, Aug. 10, 1930, represented by a plant grown under cultivation at Sacaton, Arizona, and material removed from the cultivated plant and deposited in the U. S. National Herbarium, Washington, D. C." This is the extreme opposite the type described by Rose as *O. plumbea*, and it approaches *O. phacacantha*.

***Opuntia tortispina* Engelm. and Bigel.**

The plant described previously as *Opuntia tortispina* is merely a form of *Opuntia phacacantha* with long, twisted, light-colored spines. The description was drawn from plants collected four miles south of Navajo Bridge, Coconino County, by A. A. Nichol in 1940.

ECHINOCEREUS

Mostly small cacti forming low clumps 1-4 dm. or rarely about 1 m. in diameter and rarely more than 3 (maximum 6) dm. high or the stems not infrequently solitary, the length of a single branch not more than 8 (or rarely

in a decumbent type 12) times the diameter; stem usually branching only at or near the base except after injury, or sometimes unbranched, with continuous ribs, cylindrical or ovoid, leafless even on the new season's growth; areoles not producing glochids; flower appearing below the apex of the branch; the flower bud bursting through the epidermis above the lower edge of a spine-producing areole; floral tube (hypanthium?) long or at least well-developed above the ovary; fruit spiny, the clusters of spines readily removed at maturity.

The plants of this genus occurring in Arizona are members of complex groups. Previously (Benson *et al.*, 1940) ten described species were reorganized as closely related entities, although it was clear that the group was in need of reorganization and that several species might better be reduced to varieties. Further study in the field and collection of additional herbarium and garden material emphasizes the need for the following revision. The differentiation of this genus from *Cereus* has been discussed in another paper (Benson, 1941).

KEY TO THE SPECIES

1. Petals scarlet or crimson (with plastid pigmentation?); areoles bearing white felt at maturity; flowers not closing at night, remaining open until the end of anthesis.
 1. *Echinocereus triglochidiatus*.
1. Petals purple to lavender (probably pigmented with anthocyanins); areoles not bearing white felt at maturity, the felt of the young areoles rarely persistent for two years; flowers closing at night and reopening in the morning or in hot weather withering at the end of a single day.
 2. Areoles vertically elongate; stems unbranched. 2. *Echinocereus pectinatus*.
 2. Areoles circular; stems usually branched except in young plants.
 3. Central spines 2-6, approximately the same size or at least all well developed, usually (at least the lower deflexed ones) flattened at least at the bases.
 3. *Echinocereus Engelmannii*.
 3. Central spine 1, often with 1-3 shorter accessory or rudimentary centrals in some of the areoles of the plant, circular in cross section, not flattened.
 4. Principal central spine not both strongly curved and pointing downward; spines white, gray, red, black, brown, or bicolored; flowers 5-8.5 cm. in diameter.
 4. *Echinocereus Fendleri*.
 4. Principal central spine strongly curved near the base, turned downward; spines yellow or straw-color, uniformly colored; flowers (in the specimens available) 3.5-5 cm. in diameter. 5. *Echinocereus Ledingerii*

1. *Echinocereus triglochidiatus* Engelm.

Echinocereus triglochidiatus Engelm., in WISLIZ., 1848, Mem. Tour. N. Mex., p. 93.

Cereus triglochidiatus Engelm., *apud* A. GRAY, 1849, Mem. Amer. Acad., II. 4: 50.

Echinocereus paucispinus (Engelm.) Engelm., ex. Rümpler var. *triglochidiatus* K. SCHUM., 1898, Gesamt. Kakteen, 281.

Older plants dense, forming clumps of few to many stems each 2-4 or 6 dm. high, mostly 4-8 cm. in diameter, obviously and conspicuously green, not obscured by the spines, ribs commonly 5-8, somewhat tuberculate at the areoles; spines exceedingly variable, sometimes as few as 3 or as many as 16,

1-3 cm. long; central spines 0-5 or 6, smooth and ribbed, somewhat longer than the radials; radial spines 3-10; areole circular, bearing white felt; petals crimson or scarlet, the flower about 3 cm. in diameter; floral tube 2-3 cm. long above the ovary, the scales with tufts of white hair; fruit more or less spiny, subcylindrical, about 2-3 cm. long.

Southern Colorado to trans-Pecos Texas. A few Arizona plants approach the typical variety.

Type collection: "On Wolf Creek [near Santa Fé, New Mexico], in pine woods, flowers in June [Wislizenius in 1846, *Mo.*]; Santa Fé (Fendler) . . ." *Mo.*

1A. **Echinocereus triglochidiatus** var. **gonacanthus** (Engelm. and Bigel.)
Engelm. and Bigel. *ex* W. T. Marshall

Cereus gonacanthus ENGELM. and BIGEL., 1856, Pac. R. R. Rept., 4: 33, pl. 5. f. 2-3.

Echinocereus gonacanthus Engelm., *ex* Rümpler in FÖRSTER, 1885, Handb. Cacteenk., ed. 2, p. 806.

Echinocereus paucispinus (Engelm.) Engelm., *ex* Rümpler var. *gonacanthus* K. SCHUM., 1898, Gesamtb. Kakteen, p. 281.

Echinocereus triglochidiatus var. *gonacanthus* (Engelm. and Bigel.) Engelm. and Bigel., *ex* W. T. Marshall in MARSHALL and BOCK, 1941, Cactaceae, p. 117.

A robust type similar to the typical variety; spines mostly 6-8 per areole, twisted and somewhat curved; central spine usually solitary but sometimes more than one, 3-5 cm. long, markedly angled with usually 6 or 7 sharp ribs; radial spines 2-3 cm. long.

High plains at the lower edge of the Rocky Mountain Forests at 6,000 to 8,000 feet elevation. Arizona 40 miles west of Zuñi, New Mexico, and near St. Johns, Apache County, (*Wyatt W. Jones*, the specimen with 3-angled central spines.) New Mexico near Gallup and Zuñi. Reported from the White Sands.

Type collection: "On high sand-bluffs, covered with scattering cedars, near the natural well, about 40 miles west of Zuñi, near the 109th degree. Only seen in that locality." Probably Apache County, Arizona, *Bigelow* in 1853-4, *Mo.* Zuñi, New Mexico, is within 10 or 12 miles of the Arizona line, but the 109th Meridian is just east of the state boundary.

1B. **Echinocereus triglochidiatus** var. **polyacanthus** (Engelm.) L. Benson,
comb. nov.

Echinocereus polyacanthus Engelm. in WISLIZ., 1848, Mem. Tour. N. Mex., p. 104.

Cereus polyacanthus Engelm. *apud* A. GRAY, 1849, Mem. Amer. Acad., II, 4: 50.

Echinocereus arizonicus ORCUTT, 1926, Cactography, (3): 3.

Clumps of stems not dense or dome-like, the stems usually 15-45, 1.5-5 dm. high, 6-10 cm. in diameter, elongated and cylindrical; ribs about 9-10, prominent, not markedly tuberculate at the areoles; central spines 2-4, turned downward or perpendicular to the stem, straight, stout or slender, 2.5-5 cm. long; radial spines about 10, appressed; flower about 3.5-4 cm. in diameter; floral tube about 3 cm. long above the ovary.

Desert Grassland and Southwestern Oak Woodland at 3,500 to 5,500 feet elevation. Arizona in the Pinal Mountains, Pinal County, and the Galliuro

Mountains, Graham County, and southward to Santa Cruz and Cochise counties. Southeastern Arizona to western New Mexico, Chihuahua, and Durango. Flowering late in May and in June.

Type collections: (1.) *E. polyacanthus*, "Cosihuiriachi," Chihuahua, *Wislizenius* in 1846-7, *Mo.* (2.) *E. arizonicus*, Pinal Mountains, Pinal County, Arizona.

1c. ***Echinocereus triglochidiatus* var. *melanacanthus*** (Engelm.) L. Benson, comb. nov.

Echinocereus coccineus Engelm. in WISLIZ., 1848, Mem. Tour. N. Mex., p. 93.

Cereus coccineus Engelm. *apud* A. GRAY, 1849, Mem. Amer. Acad., II, 4: 51. 1849, not Salm-Dyck *ex* DC. in 1828.

Cereus coccineus var. *melanacanthus* ENGELM., *loc. cit.*

Cereus coccineus var. *cylindricus* ENGELM., *loc. cit.*

Cereus majavensis var. *zuniensis* ENGELM. and BIGEL., 1856, Pac. R. R. Rept., 4: 33, pl. 4, f. 9.

Cereus Bigelovii Engelm. var. *zuniensis* Engelm., *apud* ENGELM. and BIGEL., 1856, *loc. cit.* (on the plate).

Cereus phoeniceus Engelm. *apud* ENGELM. and BIGEL., 1856, *loc. cit.*, p. 34, f. 1-3.

Echinocereus phoeniceus Engelm., *ex* Rümpler in FÖRSTER, 1885, Handb. Cacteenk., ed. 2, p. 788.

Echinocereus mojavensis var. *zuniensis* Engelm., *ex* Rümpler, FÖRSTER, 1885, *loc. cit.*, p. 803.

Echinocereus phoeniceus var. *inermis* K. SCHUM., 1896, Monatschr. Kakteenk., 6: 150.

Echinocereus coccineus var. *inermis* J. A. PURPUS, 1925, Mitt. Deutsch. Dendr. Ges., 1925: 49.

Echinocereus triglochidiatus var. *coccineus* Engelm., *ex* W. T. Marshall in MARSHALL and BOCK, 1941, Cactaceae, p. 117.

Echinocereus canyonensis CLOVER and JOTTER, 1941, Bull. Torrey Club, 68: 417. f. 1 (4).

Stems from a few to more than 500, cylindrical or ovoid, 0.7-1.5 dm. high, mostly 3-5 or 6 cm. in diameter; ribs commonly 8 or 10, not markedly tuberculate at the areoles; central spine 1 or sometimes more than 1, perpendicular to the joint, straight, tapering, 1.3-3 cm. long; radial spines commonly 5-10, similar to the central spine but smaller; flower 3-4.5 cm. in diameter; floral tube 2.5-3 cm. long above the ovary.

Rocky hillsides and the forest floor in the Southwestern Coniferous Woodland, the Southwestern Oak Woodland and Chaparral, and the Rocky Mountain Forests at 4,000 to 8,000 feet elevation. Arizona in the mountainous regions from the Hualpai Mountains to the Kaibab Forest, and southeastward to the Santa Catalina Mountains, Pima County, and to Greenlee County, thence southward to Santa Cruz and Cochise counties. Southern Utah to Colorado, Arizona, and New Mexico. Flowering from March until June, depending upon altitude.

Type collections: (1.) *E. coccineus*, "With the foregoing, also about Santa Fé." The "Foregoing" was *E. triglochidiatus*, see above. *Mo.* (2.) Var. *melanacanthus*, "Among a number of plants of this family which Mr. Fendler sent from Santa Fé in a living state, but which unfortunately were all dead when they came to hand, are some specimens which appear to be varieties of this species . . ." (3.) Var. *cylindricus*, cf. statement for var. *melanacanthus*. *Mo.* (4.) Var. *zuniensis*, "It was found near Cañon Diablo, on the Colorado Chiquito, about 120 miles west of Zuñi." Canyon Diablo, near the Little Colorado River, Arizona, *Bigelow* in 1853-4, *Mo.* (5.) *C. phoeniceus*, *nom. nov.* for *E. coccineus*. (6.) Var.

inermis, "... Herr C. A. Purpus aus Colorado an die hiesige berühmte Gärtnerei von SPATH schiekte..." (7.) *E. conyonensis*, "TYPE (*Clover and Jotter 2317*) collected in a sandy pocket on a steep limestone outcrop 100 yards from the [Colorado] river, Bass Cable below Hermit Creek Rapids, Grand Canyon, Coconino Co., Arizona. Locally abundant. Living specimen in the Botanical Gardens, (*Gard. 16846*), University of Michigan, Ann Arbor, Michigan." Specimen now pressed.

1D. *Echinocereus triglochidiatus* var. *mojavensis* (Engelm.) L. Benson,
comb. nov.

Cercus mojavensis ENGELM. and BIGEL., 1856, Pac. R. R. Rept., 4: 33. pl. 4.

Cercus Bigelovii Engelm., apud ENGELM. and BIGEL., 1856, *loc. cit.* (on the plate.)

Echinocereus mojavensis Engelm., ex. Rümpler in FÜRSTER, 1885, Handb. Caeteenk., ed. 2, p. 803.

Similar to var. *melanacanthus*; ribs (of the material available) strongly tuberculate at the areoles; spines curving, tortuous, somewhat flexible, whitish; floral tube (of the plants available) 1.7–2 cm. long.

Rocky hillsides in the upper Mojavean Desert and the Southwestern Coniferous Woodland at 3,500 to 5,000 feet elevation. Arizona in scattered localities in Mohave County (Black Mountains; Grand Wash Cliffs; Hualpai Indian Reservation). Southeastern California to southern Utah and northwestern Arizona.

Type collections: (1.) *C. mojavensis*, "Found between the Rio Colorado and Mojave Creek." California east of the Mojave River, *Bigelow* in 1853–4, *Mo.* (2.) *C. Bigelovii*, apparently a discarded name once intended to be proposed for the same plant.

2. *Echinocereus pectinatus* (Scheidw.) Engelm.

Echinocactus pectinatus SCHEIDW., 1838, Bull. Acad. Sci., Brux., 5: 492.

Echinocactus pectiniferus LEMAIRE, 1839, Cact. Gen. Nov. sp., p. 25.

Echinopsis pectinata FENNEL, 1843, Allg. Gartenz., 11: 282.

Echinocereus pectinatus Engelm., in WISLIZ., 1848, Mem. Tour. N. Mex., p. 110.

Cercus pectinatus Engelm., apud A. GRAY, 1849, Mem. Amer. Acad. Sci., II, 4: 50.

Cercus pectiniferus LABOURET, 1853, Monogr. Caet., p. 320.

Stem unbranched, erect, cylindrical, 1–2 dm. high, 3–8 cm. in diameter; ribs about 20, not markedly tuberculate at the areoles, but transversely grooved between adjacent areoles; spines white to red, not completely obliterating the stem; central spines 2–5, mostly 3, mostly 1–3 mm. long, in a single row; radial spines 15–20, appressed against the stem, pectinate, markedly appressed, 3–8 mm. long, flattened, straight, tapering; areoles vertically elongate, the growth of different years marked off by the color of the spines produced in early or late season; flower funnel-form; petals reddish-purple, tending toward lavender; floral tube about 12 mm. long above the ovary; fruit nearly spherical, about 2.5 cm. in diameter.

Rocky or gravelly hills in the Desert Grassland and perhaps the Southwestern Oak Woodland at 4,000 to 5,000 feet elevation. Southeastern Arizona to Chihuahua. The plant occurring in Cochise County, Arizona, seems to be referable to the typical variety, but it has not been seen in flower (Perilla Mts.,

Harlan in 1939, *Sac.*; near Douglas, W. W. Jones UA, B; 16 miles northeast of Douglas, Benson and Darrow 11113, UA, B). This is one of several Chihuahuan Desert species occurring on limestone hills in southeastern Arizona.

Type collection: The identity of the type is difficult to establish. According to Britton and Rose, *Cactaceae*, 3: 29-30, 1922, "This species was first collected by Galeotti who sent a collection to Belgium from the states of San Luis Potosi and Guanajuato, Mexico. The type station, Villa del Pennaseo, we have not located. It was soon after figured by Lemaire (*Icon. Cact.*, pl. 14 or 15) and Pfeiffer (*Abbild. Besch. Cact.*, 2: pl. 10), very likely from the type collection." According to Engelmann, *loc. cit.*, however, the type is from Chihuahua: "The description of the plant (which died without producing flowers) found in several works, as well as in the latest publication on *Cactaceae*, before me, of Foerster, Leipzig, 1846, was made, as Prince Salm informed me, from specimens sent from Chihuahua by Mr. Potts. It entirely agrees with my specimen from the same region."

2A. *Echinocereus pectinatus* var. *rigidissimus* (Engelm.)

Engelm. *ex* Rümpler

Cereus pectinatus (Scheidw.) Engelm., var. *rigidissimus* ENGELM., 1857, *Proc. Amer. Acad.*, 3: 279.

Echinocereus rigidissimus ROSE, 1909, *Contr. U. S. Nat. Herb.*, 12: 293.

Echinocereus dasyacanthus Engelm., var. *rigidissimus* W. T. Marshall in MARSHALL and Bock, 1941, *Cactaceae*, p. 119.

Stems 0.7-3.5 dm. high, 5-10 cm. in diameter; areoles crowded, the spines completely obliterating the surface of the stem; central spines none; radial spines flat, thicker and stronger than in the typical variety, 15-18, strongly appressed, 6-14 mm. long; flowers between lavender and magenta.

Occurring on rocky slopes and grassy areas in the Desert Grassland and the Southwestern Oak Woodland at 4,000 to 6,000 feet elevation. Arizona from the Baboquivari Mountains to the Santa Catalina Mountains, Pima County, and southeastward to Santa Cruz and Cochise counties; northern Sonora.

Type collection: "... from Sonora ..." According to Engelmann, in Emory, *Rept. U. S. and Mex. Bound. Surv.*, 2: 32, 1859. "In the Sierras of Pimeria Alta in Sonora, and farther west (A. Schott). Flowers in June and July." *Mo.*

2B. *Echinocereus pectinatus* var. *neomexicanus* (Coulter) L. Benson, comb. nov.

Echinocereus dasyacanthus Engelm., in WISLIZ., 1848, *Mem. Tour. N. Mex.*, p. 100.

Cereus dasyacanthus Engelm., *apud* A. GRAY, 1849, *Mem. Amer. Acad.*, II, 4: 50.

Cereus etnoides Engelm., in EMORY, 1839, *Rept. U. S. and Mex. Bound. Surv.*, 2: 31, pl. 42.

Cereus etnoides Engelm., et Rümpler in FÖRSTER, 1885, *Hand. Cacteenk.*, ed. 2, p. 819, f. 109.

Cereus dasyacanthus var. *neomexicanus* COULT., 1896, *Contr. U. S. Nat. Herb.*, 3: 384.

Not *Echinocereus neomexicanus* STANDL., 1908, *Bull. Torrey Club*, 35: 87.

Stems 1-3 dm. high, 5-7 or 10 cm. in diameter; areoles crowded, the spines usually practically obliterating the surface of the stem; central spines mostly 5-8, usually arranged irregularly (or in a single row in types transitional to the typical variety), 3-10 mm. long; radial spines somewhat flattened, 15-20 or more, not markedly appressed, 10-15 mm. long; flowers typically yellow but sometimes varying to the magenta series.

Desert Grassland and Oak Woodland at 4,000 to 5,000 feet elevation. Arizona (according to Professor Thornber) in the southern part of the Baboquivari Mountains, Pima County, and (according to A. A. Nichol) in the Perilla and Guadalupe mountains, Cochise County, as well as (according to A. A. Nichol) in perhaps modified form in the Oro Blanco Mountains west of Nogales, Santa Cruz County, and at Altar and Pitiquito in adjacent Sonora; Southern New Mexico; Trans-Pecos Texas; Chihuahua.

Type collections: (1.) *E. dasyacanthus*, "On the mountains near El Paso; in August in flower and fruit." *Wislizenius* in 1846-7, *Mo.* (2.) *C. etenoides*, "From Eagle Pass to Santa Rosa (Bigelow); on the Pecos (Wright)." *Texas. Mo.* (3.) Var. *neomexicanus*, "Type, Wright 366 in Herb. Mo. Bot. Gard. Southeastern New Mexico." The necessity for use of this name in varietal status is unfortunate, for the little-known epithet *neomexicanus* displaces the well-known one, *dasyacanthus*, and the epithet *neomexicanus* was proposed later in specific rank for a plant of the *Echinocereus triglochidiatus* complex.

3. *Echinocereus Engelmannii* (Parry) Parry *ex* Rümpler

Cereus Engelmannii Parry *ex* ENGELM., 1852, *Amer. Jour. Sci.*, II, 14: 338.

Cereus Engelmannii var. *variegatus* ENGELM., 1856, *Pac. R. R. Rept.*, 4: 35, pl. 5. f. 4-7.

Cereus Engelmannii var. *chrysocentrus* ENGELM., 1856, *loc. cit.*, f. 8-10.

Echinocereus Engelmannii (Parry) Parry *ex* Rümpler in FÖRSTER, 1885, *Handb. Cacteenk.*, ed. 2, p. 805.

Echinocereus Engelmannii var. *variegatus* Engelm., *ex* Rümpler, FÖRSTER, 1885, *loc. cit.*, p. 806.

Echinocereus Engelmannii var. *chrysocentrus* Engelm., *ex* Rümpler, FÖRSTER, 1885, *loc. cit.*, p. 806.

Echinocereus chrysocentrus ORCUTT, 1926, *Cactography*, (3): 4.

Clumps not dense, stems erect, usually 1-25, not crowded, cylindrical, usually 1.5-3 dm. high, 5-7.5 cm. in diameter, firm, ribs usually 10-13, not markedly tuberculate at the areoles; spines sometimes obliterating the surface of the stem; central spines 2-6, all large and well-developed, red, yellow, white, brown, or gray, or the lower one white and the others variously colored, some of them deflexed, tapering, 3.7-9 cm. long, stout but somewhat flexible, curving or twisted, usually flattened at the bases; radial spines 6-12, similar to the central but smaller; areole circular or nearly so, not bearing white felt after the first year; petals purple to magenta, the flower 5-7.5 cm. in diameter, funnel-form; floral tube about 12 mm. long above the ovary; fruit red, nearly spherical to ovoid, about 3 cm. long, spiny, shedding the interlocking spines at maturity, edible.

Hills, plains, alluvial bottoms, and benches in the Northern, Mojavean, and Sonoran deserts at 100 to 2,500 or rarely 5,000 feet elevation. California about the Owens River Valley and in the Mojave and Colorado deserts; southern Nevada; southern Utah; Arizona from southern Mohave County to Yuma County, Pinal County, and western Pima County; Baja California to Sonora. Flowering in late March and in April.

Type collections: (1.) *C. Engelmannii*, "Mountains about San Felipe, on the eastern declivity of the Cordilleras." Colorado Desert in San Diego County, California, *Parry* in

1852. *Mo.* (2.) Var. *variegatus*, "On the Cactus mountains and at the head of Williams River; degrees 113½ longitude." Arizona, *Bigelow* in 1853-4 *Mo.* (3.) Var. *chrysoacutrus*, "It was found where *C. variegatus* [var. *variegatus*] disappears on the lower part of Williams's River, and was seen from there to Mojave Creek, and up that stream to the Sierra Nevada." Western Arizona and California, *Bigelow* in 1853-4, *Mo.* The species is barely to be maintained as distinct from *E. Fendleri*, and the separation is rather arbitrary.

3A. **Echinocereus Engelmanni** var. **Nicholii** L. Benson, var. nov.

Plate 25, fig. B.

Caulibus 10-30 erectis, 3-5 dm. longis, 5-7 vel 8 cm. diametro; aculeis flavis; petalis colore similibus lavendulae.

Stems erect, in large clumps of 10-30, 3-5 dm. high, 5-7 or 8 cm. in diameter; spines all yellow; petals lavender.

Common on rocky hillsides in the Sonoran Desert at 1,000 to 2,000 feet elevation; not occurring on the alluvial flats between the mountains. Arizona in western Pima County from the Organ Pipe Cactus National Monument to the Silver Bell Mountains; largely on the Papago Indian Reservation.

Type collection: **Silver Bell Mine, Silver Bell Mountains, Pima County, Arizona, L. Benson 10720**, March 28, 1941, TYPE *UA*; ISOTYPE *B*. Mr. A. A. Nichol has brought many plants of this variety to the University of Arizona on the supposition that they were a new entity.

3B. **Echinocereus Engelmanni** var. **decumbens** (Clover and Jotter),

L. Benson, comb. nov.

Echinocereus decumbens CLOVER and JOTTER, 1941, Bull. Torrey Club, 68: 417, fig. 7, 1941.

Stems decumbent, up to 50 or more, forming dense masses, elongated and slender, 2-6 dm. long, 3-5 cm. in diameter; spines yellowish to white or pinkish, the lower deflexed and flattened central spine 2.5-3.5 cm. long, the other centrals and the radials 1.5-2.3 cm. long, relatively weak and flexible; flowers unknown.

Talus and ledges in precipitous canyons of the Sonoran Desert at about 2,000 to 3,000 feet elevation. Arizona at Mile 16½, Marble Canyon, Colorado River, Coconino County, and at Palm Canyon, Kofa Mountains, Yuma County (*Benson and Darrow 10870 UA, B*). The Palm Canyon plant grew on top of a huge boulder where almost no soil was present, and it covered an area three or four feet in diameter.

Type collection: "Type on limestone ledge 30 feet from the river's edge and at the base of rocky talus at Mile 16½ Marble Canyon, Coconino Co., Arizona (*Clover and Jotter 2212*). Living specimen at the Botanical Gardens of the University of Michigan, Ann Arbor, Michigan (*Gard. 16870, Fig. 7*)." Specimen now pressed.

4. **Echinocereus Fendleri** (Engelm.), Engelm. ex Rümpler

Cercus Fendleri Engelm., *apud* A. GRAY, 1849, Mem. Amer. Acad., II. 4: 51.

Cercus Fendleri var. *pauperculus* Engelm., A. GRAY, 1849, *loc. cit.*

Echinocereus Fendleri (Engelm.), Engelm. ex Rümpler in FÖRSTER, 1885, Handb. Caeteenk., ed. 2, p. 801.

Clumps not dense, the stems 1-5 or perhaps more, not crowded against one another, ovoid, 7-15 cm. long, 5-10 cm. in diameter, flaccid, ribs usually about 9-10, not markedly tuberculate at the areoles; spines not obliterating the surface of the stem; central spine 1, at first very dark brown to black, gray in age, turned upward from the base, tapering, 2-4.5 cm. long, stout, slightly curving upward the entire length, rigid, not flattened; radial spines 9-11, similar to the central but shorter and white or pale gray; areole circular, not bearing white felt at maturity, the felt rarely persisting two years; petals magenta to purplish, the flower about 5-7 cm. in diameter; floral tube about 12 mm. long above the ovary; fruit ovoid, about 3 cm. long, spiny, the spine-clusters interlocking, falling away as a sheet at maturity.

Grassland and open areas in the Rocky Mountain Forests at 5,000 to 7,000 feet elevation. Northern Arizona in Coconino, Navajo, and Apache counties; southern Utah; northern New Mexico.

Type collections: (1.) *C. Fendleri*, "Santa Fe, on elevated sandy plains; flowering in June." *Fendler, Mo.* (2.) Var. *pauperculus*, apparently collected in the same vicinity by *Fendler, Mo.*

4A. ***Echinocereus Fendleri* var. *rectispinus*** (Peebles), L. Benson, comb. nov.

Echinocereus rectispinus PEEBLES, 1938, Amer. Jour. Bot., 25: 675, f. 1, 3d.

Stems 1-5, usually 1-2 dm. high, 6-9 cm. in diameter, firm, the ribs 8-10; central spine perpendicular to the stem, straight, 1.2-2.5 cm. long, in some areoles accompanied by small accessory centrals, rigid, rather stout; flower about 6-6.5 cm. in diameter.

Rocky slopes and benches in the Desert Grassland at 3,500 to 5,500 feet elevation. Arizona from Nogales and the Santa Rita Mountains to Ft. Grant and Cochise County.

Type collection: "Type: Peebles No. SF 905 (fig. 1), hills near Nogales, Arizona, elevation 3,900 feet, May 5, 1935, represented by a living plant under cultivation at U. S. Field Station, Sacaton, Ariz., and by material deposited in the U. S. National Herbarium as No. 1729266."

4B. ***Echinocereus Fendleri* var. *robustus*** (Peebles), L. Benson, comb. nov.

Echinocereus rectispinus Peebles var. *robustus* PEEBLES, 1938, Amer. Jour. Bot., 25: 675, f. 3c.

Echinocereus robustus PEEBLES, 1940, Jour. Wash. Acad. Sci., 30: 219.

Stems 5-20, 1.7-4.5 dm. high, mostly 8-10 cm. in diameter, ribs 8-13, firm; central spine straight, perpendicular to the stem, 2.5-7.5 cm. long, in some areoles accompanied by small accessory centrals, rather flexible, slender; flower usually 7.5-8.5 cm. in diameter.

Rocky slopes in the Sonoran and Chihuahuan deserts and the lower part of the Desert Grassland at 2,000 to 4,000 feet elevation. Arizona from eastern Pinal County and eastern Pima County to the upper Gila River valley and the lower parts of Cochise County. This is the only *Echinocereus* in the desert about Tucson. Flowering in April and May. Closely related to the next variety.

Type collection: "Type: *Pebbles* No. SF 896, Tucson to Sabino Canyon, Pima County, Arizona, August 27, 1935, represented by a living plant grown under cultivation at Sacaton, Ariz., and by material deposited in the U. S. National Herbarium as No. 1729267."

4c. ***Echinocereus Fendleri* var. *Boyce-Thompsonii*** (Orcutt), L. Benson, comb. nov.

Echinocereus Boyce-Thompsonii ORCUTT, 1926, *Caetography*, (3): 4.

Stems 1-10, 1-2.5 dm. high, 5-7.5 cm. in diameter, rather firm, ribs 12 or commonly 14-18 or sometimes more; central spine 2.5-4 cm. long, accompanied in at least some areoles by 1 or 2 accessory centrals, perpendicular to the stem or more commonly deflexed, straight, flexible, very slender, remarkably light-colored, either straw-colored, reddish, or white (gray in the two preceding varieties); flower usually about 6-6.5 cm. in diameter. This variety is transitional in some of its forms to *Echinocereus Engelmannii*.

Rocky slopes or grassy uplands in the upper part of the Sonoran Desert, the Desert Grassland, the Southwestern Coniferous Woodland, and the Southwestern Oak Woodland at mostly 2,500 to 5,500 feet elevation. Central Arizona from the vicinity of Seligman southeastward just below the Mogollon Rim to the upper Gila River Valley. Flowering from March until May.

Type collection: "Grounds of the Boyce-Thompson Southwestern Arboretum, near Superior, Arizona, at an elevation of about 2,300 feet." The original description was reprinted by Peebles, *Amer. Jour. Bot.*, 25: 677. 1938.

4d. ***Echinocereus Fendleri* var. *Bonkeræ*** (Thornber and Bonker), L. Benson, comb. nov.

Echinocereus Bonkeræ THORNBUR and BONKER, 1832, *Fantastic Clan*, p. 71-3, 85, pl. opposite p. 28, 72.

Clumps rather dense for the group, the stems usually 5-15, 1.2-2 dm. high, 3.5-6.5 cm. in diameter, rather firm, ribs 11 or 13-16; central spine 6-8 mm. long, accompanied in some areoles by 1 or 2 accessory centrals, perpendicular to the stem, rigid, white or pale gray tipped with brown; flower tending toward purple, about 6-6.5 cm. in diameter, the petals and sepals more nearly rotate than in the other varieties, or even slightly reflexed.

Hills and slopes in the Desert Grassland and the Southwestern Oak Woodland at 3,500 to 5,000 feet elevation; best developed in shady situations where leaf-mold is present. Arizona from the vicinity of Globe to the Santa Catalina Mountains and the Graham (Pinaleno) Mountains. Specimens collected by A. A. Nichol in 1940 are clearly transitional between this and var. *Boyce-Thompsonii*.

Type collection: "We are nearing the beautiful Pinal Mountains in southeastern Arizona. . . ." According to A. A. Nichol, the plant described by Professor Thornber was from near Oracle at the north base of the Santa Catalina Mountains. Mr. Nichol planted the specimens in the University of Arizona Cactus Garden, and in 1939, the writer placed the remains of the last individual in the University Herbarium. They are the closest approach to a type. Coulter, *Contr. U. S. Nat. Herb.*, 3: 384, 1896, described a plant probably of this variety from Oracle (*Evans* in 1891), placing the vegetative material near *Cereus ctenoides*

Engelm. (*Echinocereus pectinatus* var. *neomexicanus* above). Britton and Rose, *Cactaceae*, 2: 37, 1922, published a photograph of this plant (fig. 45) as *E. Fendleri*.

5. *Echinocereus Ledingii* Peebles

Echinocereus Ledingii PEEBLES, 1936, *Cact. and Succ. Jour.*, 8: 35.

Clumps not particularly dense; longer stems cylindrical, 1.5–4 or 5 dm. high, 6–9 or 10 cm. in diameter, ribs 12–16, not markedly tuberculate at the areoles; spines not completely obliterating the surface of the stem, light yellow or straw-color; central spine 1, but often accompanied by 1–3 short upper accessory centrals, deflexed and strongly curved downward near the base, about 2 cm. long, stout, rigid, tapering; radial spines about 10–12, straight, about 9 mm. long; areole circular or nearly so, not bearing white felt; petals rose-purple, the flower 3.5–5 cm. in diameter; floral tube about 9 mm. long above the ovary; fruit pale green, spherical, a little less than 1 inch in diameter, spiny when young.

Slopes in the Southwestern Oak Woodland at 4,500 to 6,000 feet elevation. Southeastern Arizona in the Quinlan, Santa Catalina, Santa Rita, Huachuca, Graham (Pinaleno), and Chiricahua Mountains in Pima, Graham, Santa Cruz, and Cochise counties. Perhaps endemic in Arizona. The localities are based upon records supplied by A. A. Nichol; specimens have been obtained only from the Graham Mountains.

Type collection: "Type collected at about 4,500 feet elevation on slopes of Mt. Graham, Pinaleno Mountains, Graham Co., Arizona, Louis Wankum, July 11, 1935, U. S. Nat. Herb. No. 1,634,004."

ECHINOCACTUS

In this genus only a few changes are proposed now, and other problems are deferred pending accumulation of additional data.

Echinocactus acanthodes Lemaire

Echinocactus acanthodes LEMAIRE, 1839, *Cact. Gen. Nov. Sp.*, p. 106.

Echinocactus viridescens var. *cylindraceus* ENGELM., 1852, *Amer. Jour. Sci.*, II: 338.

Echinocactus LeContei ENGELM., 1856, *Pac. R. R. Rept.*, 4: 29.

Echinocactus cylindraceus ENGELM., 1857, *Proc. Amer. Acad.*, 3: 275.

Echinocactus Wislizenii Engelm. var. *LeContei* Engelm. in ROTHROCK, 1878, *Rept. U. S. Geogr. Surv.*, 6: 128.

Ferocactus LeContei BRITT. and ROSE, 1922, *Cactaceae*, 3: 129.

Ferocactus acanthodes BRITT. and ROSE, 1922, *loc. cit.*

Ferocactus Rostii BRITT. and ROSE, 1922, *loc. cit.*, p. 146.

Echinocactus Hertrichii WEINBERG, 1929, *Desert*, 1: 40.

Ferocactus acanthodes var. *Rostii* W. T. Marshall in MARSHALL and BOCK, 1941, *Cactaceae*, p. 148.

The common barrel cactus in western and central Arizona does not seem to have any points of consistent difference from the type common in the California deserts. Previously (Benson *et al.*, 1940) it was treated as a species pending further investigation, but with the following statement, "Probably merely a form of *Echinocactus acanthodes*."

Type collections: (1.) *E. acanthodes*, type collected in California. (2.) Var. *cylindraceus*, "Found near San Felipe, on the eastern slope of the California Mountains." Colorado Desert, San Diego County, Parry, Mo. (3.) *E. LeContei*, "This gigantic species was first noticed by Dr. John L. LeConte, on the lower Gila, where also Dr. C. C. Parry saw it. . . . Subsequently, Dr. Bigelow met with this remarkable plant, abundantly from the Cactus Pass, at the headwaters of Williams' River down this stream to the Colorado, and west of it till *E. polycephalus* took its place." (4.) *F. Rostii*, "The type is based on a plant collected in Lower California, 40 miles south of the International Boundary Line (Rost No. 327)." (5.) *E. Hertrichii*, "Type specimen: Huntington's Botanischer Garten und Museum, San Marino, California." "Type—Weinberg in Henry E. Huntington's Botanic Garden, San Marino, Calif. Locality—Tortilla and Gila mountains, Arizona."

***Echinocactus polycephalus* Engelm. var. *xeranthemoides* Coulter**

Echinocactus polycephalus Engelm. var. *xeranthemoides* COULT., 1896, Contr. U. S. Nat. Herb., 3: 385.

Echinocactus xeranthemoides Engelm. ex COULT., 1896, loc. cit., as syn.

Echinocactus xeranthemoides Engelm. ex RYDB., 1917, Fl. Rocky Mts. and adj. Plains, p. 579.

Stems rarely more than 12, the largest ones 1–2 dm. in diameter, the clump usually asymmetrical, that is, the tallest stem on the edge; spines glabrous, yellow or pale gray tinged with red or sometimes pink or light red; central spines spreading at right angles to the stem. (In the typical variety: stems commonly 10–30, the larger ones 2–3 dm. in diameter, the clump symmetrical, that is with the largest stem in the center; spines densely covered with felt when young, red; central spines spreading each in a low arc.)

Rocky, south-facing ledges in the Southwestern Coniferous Woodland at 4,000 to 7,000 feet elevation. Arizona in the northern edge of Mohave County and along the Colorado River system from Lee's Ferry and Canyon Diablo to the Grand Canyon region; southern Utah.

Type collection: "Type, Siler of 1881 and 1883 in Herb. Mo. Bot. Gard."

MAMMILLARIA

As in *Echinocactus* and *Opuntia*, although a number of problems exist, data for solution of some of them are inadequate. Only the following changes are proposed.

***Mammillaria vivipara* (Nutt.) Haw. var. *aggregata* (Engelm.), L. Benson, comb. nov.**

Mammillaria aggregata Engelm. in EMORY, 1848, Notes Mil. Recon., p. 146.

Cercus aggregatus COULT., 1896, Contr. U. S. Nat. Herb., 3: 396.

Echinocercus aggregatus RYDB., 1906, Bull. Torrey Club, 33: 146.

Coryphantha aggregata BRITT. and ROSE, 1923, Cactaceae, 4: 47.

Low-growing plant, the stems at first solitary but later forming mounds 2–6 dm. high and up to 6 dm. in diameter; stems 4–5 cm. in diameter at maturity, tubercles cylindrical, about 8–10 mm. high, about 6 mm. in diameter, the surface of the stem obliterated by spines; central spines usually 5–6, white tipped with brown, straight, the upper ones turned upward, 1.5–2 cm. long, the lower ones spreading at various angles from the stem, about 6–9 mm. long,

tapering, slender but rigid, not flattened, the centrals appearing after the radials and not present in young stems; radial spines 15–20, similar to the centrals, white, slightly brownish at the extreme tips, 12–18 or 25 mm. long, somewhat flattened; petals usually lavender or pink, oblanceolate, rather abruptly acuminate, 4–6 mm. broad, the flower about 3.5–4 cm. in diameter; fruit green with a dull purplish tinge, ellipsoid, about 2.5 cm. long, 1.8 mm. in diameter.

River bottoms, the desert floor, or most frequently on grassy plains or rocky slopes in the upper part of the Sonoran Desert, the Desert Grassland, and the Southwestern Oak Woodland and Chaparral at 3,000 to 5,000 or 6,000 feet elevation. The eastern half of southern Arizona; largely south of the Mogollon Rim; New Mexico on the Gila River drainage; Sonora. Flowering in May and June.

Type collection: "Oct. 18, 1846. Head waters of the Gila, 6,000 feet above the sea." Interpretations of the type have alternated between this plant and *Echinocereus triglochidiatus* var. *melananthus*. Engelmann, *loc. cit.*, first interpreted the plant as a member of the *Mammillaria vivipara* complex, and (as pointed out by Peebles apud Kearney and Peebles, U. S. Dept. Agric. Misc. Publ., (423): 605, 1942, the original drawing shows crossed spirals indicating tubercles on the stem. The type was not preserved, or was lost.

***Mammillaria vivipara* var. *arizonica* (Engelm.) L. Benson, comb. nov.**

Mammillaria arizonica Engelm. in BREW. and WATS., 1876, Bot. Calif., ed. 1, 1: 244.

Cactus radiosus (Engelm.) Coult. var. *arizonica* COULT., 1894, Contr. U. S. Nat. Herb., 3: 121.

Mammillaria radiosa Engelm. var. *arizonica* K. SCHUM., 1898, Gesamtb. Kakteen, p. 481.

Coryphantha arizonica BRITT. and ROSE, 1923, Caetaceae, 4: 45.

Stems solitary at first, later forming great mounds; spines predominantly dark brown; lower central spines 2, one of these spreading perpendicularly (to the areole), the other turned downward; petals deep pink, linear-lanceolate, gradually acuminate, 2.5–4 mm. broad.

Rocky places in the Southwestern Coniferous Woodland and the Rocky Mountain Forests at 4,000 to 8,000 feet elevation. Southwestern Utah; northern Arizona from Mohave County to Apache County and southward to the Mogollon Rim and the White Mountains, and perhaps farther in the higher mountains.

Type collection: "On sandy and rocky soil in Northern Arizona, from the Colorado eastward (Coues, Palmer, F. Bischoff), and into Southern Utah (J. E. Johnson) . . ."

***Mammillaria vivipara* var. *deserti* (Engelm.), L. Benson, comb. nov.**

Mammillaria chlorantha Engelm. apud Rothr., in WHEELER, 1878, U. S. Geogr. Surv. W. of 100th Merid., 6: 127.

Mammillaria deserti Engelm. in S. WATS., 1880, Bot. Calif., 2: 449.

Cactus radiosus (Engelm.) Coult. var. *deserti* COULT., 1894, Contr. U. S. Nat. Herb., 3: 121.

Cactus radiosus var. *chloranthus* COULT., 1894, *loc. cit.*

Cactus radiosus var. *Alversonii* COULT., 1894, *loc. cit.*, p. 122.

Mammillaria Alversonii ZEISSOLD, 1895, Monatssehr. Kakteenk., 5: 70.

Mammillaria radiosa Engelm. var. *deserti* K. SCHUM., 1898, Gesamtb. Kakteen, p. 481.

Mammillaria radiosa var. *chlorantha* K. SCHUM., 1898, *loc. cit.*

Mammillaria radiosa var. *Alversonii* K. SCHUM., 1898, *loc. cit.*

Coryphantha chlorantha BRITT. and ROSE, 1923, *Cactaceae*, 4: 43.

Coryphantha arizonica BRITT. and ROSE, 1923, *loc. cit.*, p. 45.

Coryphantha deserti BRITT. and ROSE, 1923, *loc. cit.*, p. 45.

Mammillaria arizonica Engelm. var. *deserti* Engelm. ex DAVIDSON and MOXLEY, 1923, *Fl. S. Calif.*, p. 244.

Mammillaria arizonica var. *Alversonii* Engelm. ex DAVIDSON and MOXLEY, 1923, *loc. cit.*

Coryphantha Alversonii ORCUTT, 1926, *Cactography*, (3): 3.

A robust type with the stems usually solitary or sometimes few, these 7–20 cm. high, 5–7.5 cm. in diameter; central spines 3–14, usually white tipped with brown, straight, spreading at all angles, 12–18 mm. in length, averaging long, tapering, stout, rigid, not flattened; radial spines about 20, similar to the centrals but more slender, white; petals straw-colored, yellow, pink, or purple, the flowers 2.5–3.5 cm. in diameter.

Rocky slopes in the Mojavean Desert at 1,500 to 3,500 feet elevation. California in the ranges of the eastern and southern parts of the Mojave Desert; southern Nevada; southwestern Utah; northwestern Arizona in northern and western Mohave County. A variable plant possibly to be segregated into more than one variety with accumulation of additional data. The characters of the proposed segregates seem inconsistent in their association.

Type collections: (1.) *M. chlorantha*, "Southern Utah, east of Saint George, Dr. Parry. I. E. Johnson." (2.) *M. deserti*, "At Ivanpah, 30 miles northeast of San Bernardino, in one of the mountain ranges stretching into the desert, S. B. Parish." *Mo.* Ivanpah is in the New York Mountains, about 140 miles northeast of San Bernardino, California. (3.) Var. *Alversonii*, "Type, Alverson's specimens in the Herb. Mo. Bot. Gard. and Herb. Coulter . . . SOUTHERN CALIFORNIA (*A. H. Alverson* of 1892). . . . The decidedly pink flowers were sent by Mr. S. B. Parish from specimens growing in cultivation in San Diego, and are not from the original collection of Mr. Alverson."

***Mammillaria Heyderi* Mühlenpfordt**

Mammillaria Heyderi MÜHLENPFORDT, 1848, *Allg. Gartenz.*, 16: 20.

Cactus Heyderi KUNTZE, 1891, *Rev. Gen. et Sp. Pl.*, 1: 260.

Neomammillaria Heyderi BRITT. and ROSE, 1923, *Cactaceae*, 4: 75.

Obscure depressed cactus arising only 1–5 cm. above ground level; stem solitary, shaped like a turnip, flat-topped, half or two-thirds subterranean, 5–8 cm. long, 7–12 cm. in diameter, the tubercles conical, 6–10 mm. high, 5–7 mm. in diameter; juice of the plant milky; central spines 2–3, white tipped with dark brown, straight and subequal, 6–8 mm. long, tapering, slender, rigid, not flattened; radial spines 10–15; petals pink; sepals not fringed; flower 10–12 mm. in diameter.

Limestone hills in the Chihuahuan Desert or the Desert Grassland at 3,500 to 5,000 feet elevation. Along the Mexican Border in Cochise County near Bisbee (*Pebbles SF 922, Sac, UA*) and in the Peloncillo Mountains (*L. Benson 10272, UA, B*). One of several Chihuahuan Desert plants barely reaching southeastern Arizona and there restricted to favorable limestone soils.

Type collection: none given.

Mammillaria Heyderi var. **MacDougalii** (Rose) L. Benson, comb. nov.

Mammillaria MacDougalii Rose in BAILEY, 1916, Stand. Cyclop. Hort., ed. 1. 4: 1982.

Neomammillaria MacDougalii BRITT. and ROSE, 1923, Cactaceae, 4: 74.

Stems 5–7.5 or 12.5 cm. long, 7.5–17.5 cm. in diameter; central spines straight or the principal one curving gradually outward; petals cream-colored or light yellow; sepals fringed; flower about 17–20 mm. in diameter.

South exposures of rocky hill crests in the Desert Grassland and the Southwestern Oak Woodland at 4,000 to 6,000 feet elevation; often in crevices of rocks or in rocky soil. Arizona from the Baboquivari Mountains eastward to the Santa Catalina Mountains and to southern Cochise County; probably in adjacent Sonora. Often associated with *Echinocereus pectinatus* var. *rigidissimus*, the Arizona rainbow cactus. Flowering late in March and in April.

Type collection: "Common in the mountains about Tucson, Ariz., where it was collected by D. T. MacDougal, for whom it is named."

The dimorphic fruits of some of the typical *Mammillaria* species, including *M. Heyderi* and the variety *MacDougalii* have been well-known for some time, and Peebles, Cact. and Succ. Jour., 13: 143–5, 1941, has reported and illustrated similar types (clavate-red and spherical-green) in *Mammillaria microcarpa*. They occur also in *Mammillaria fasciculata* (15 miles west of Silver Bell, Pima County, Arizona, L. Benson 10606, UA, B).

The plants described previously as *Mammillaria microcarpa* Engelm., *M. fasciculata* Engelm., *M. Wilcoxii* Toumey, *M. viridiflora* (Britt. and Rose) Boed., and *M. Mainae* K. Brandegee are in need of further study, but at present data are inadequate.

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EXPLANATION OF PLATE

Plate 25

Opuntia and *Echinocereus*: *A*, *Opuntia*, 1, *Opuntia compressa* var. *macrorhiza*, collected at Pearce, Arizona, by A. A. Nichol in 1940, 2, *Opuntia compressa* var. *macrorhiza*, from sand hills near Guion, Arkansas, *Demaree 23490*, 3, *Opuntia compressa*, from the Atlantic seaboard, received from cultivation in Massachusetts; *B*, *Echinocereus Engelmannii* var. *Nicholii*, growing in the Ajo Mountains, Arizona. (Photograph *A* by Robert A. Darrow; *B* by Walter S. Phillips.)



